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materials bureau technical services division

TECHNICAL REPORT 86-4

ASPHALT CEMENT MONITOR PROGRAM FALL 1985

MARCH, 1986

RECEIVED
JUN 13 1986
N.Y.S. DOT
Engrg. Res. & Dev.

M.A.P. CODE 7.42-6-86-4

TECHNICAL REPORT 86-4

ASPHALT CEMENT MONITOR PROGRAM
FALL 1985

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March 1986

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M.A.P. CODE 7.42-6-86-4

Preface

Each year the Materials Bureau conducts a monitor testing program in cooperation with various suppliers of asphalt cement. Samples are obtained by Bureau personnel and split for testing by both the supplier and the Bureau in accordance with standard AASHTO test procedures. This report summarizes the results of the 1985 program.

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I. Introduction

During September and October 1985, personnel from the Materials Bureau Chemistry Laboratory Section obtained twenty-two samples from fifteen suppliers of asphalt cement. These samples represented many of the sources which had supplied material to the Department during the 1985 construction season including Boscan, Maya, Mid-Continent, Canadian, Arab, Venezuelan and other various crude sources.

At the time of sampling, the twenty two samples were split into two parts. One part was given to the asphalt supplier while the other was returned to the Bureau's Laboratory. All tests were conducted in accordance with the applicable AASHTO test procedures.

Two standard test report forms and one sample identification form were provided by the Bureau for recording sample information and all test results. Each supplier submitted the test results to the Bureau for review and incorporation into this report.

II. Sample Information

A. The distribution of the samples by grade was as follows:

Grade	Number of Samples
Flux	5
AC-5	1
AC-15	6
AC-20	7
85/100	3

B. The supplier, location, crude source and lot numbers are tabulated below.

Flux

Supplier	Location	Lot	Crude Source
Chevron	Perth Amboy, NJ	15	Mexico Mayan
Cibro	Albany, NY	56	Boscan
Gulf Canada	Mississauga, Ont.	-	Western Canadian
Marathon	Tonawanda, NY	3	Mid Continent and Canadian
United Refining	Warren, PA	43	Canadian

AC-5

Supplier	Location	Lot	Crude Source
Petro Canada	Oakville, Ont.	332	Bow River

AC-15

Supplier	Location	Lot	Crude Source
Gulf Canada	Mississauga, Ont.	85/28	Western Canadian
Marathon	Tonawanda, NY	19	Mid Continent and Canadian
NoCo Energy	Tonwanada, NY	6	Bow River Canadian
Petro Canada	Oakville, Ont.	330	Bow River
United Refining	Warren, PA	44	Canadian
Warden	Pittsford, NY	190	Canadian

AC-20

Supplier	Location	Lot	Crude Source
Arco	Philadelphia, PA	3A	North Slope, Maya, Venezuelan
Chevron	Perth Amboy, NJ	14	Venezuelan, Boscan, Pilon
Cibro	Albany, NY	53	Bachacaro
Exxon	Linden, NJ	13	63% North Slope 37% Maya
Marathon	Tonawanda, NY	20	Mid Continent and Canadian
Peckham	Stamford, CT	29	——
West Bank	Perth Amboy, NJ	11	Venezuelan

85/100

Supplier	Location	Lot	Crude Source
Gulf Canada	Montreal, Que.	58	Mexican
Petro Canada	Montreal, Que.	1	Mexican Menemota (Venezuelan)
Shell Canada	Montreal, Que.	85/9	Canadian, Mexican and various off shore crudes

III. Test Performed

A. Tests required by Department of Transportation Specification:
(all tests not required on all items of asphalt cement)

1. Viscosity @ 140°F, Absolute, (AASHTO T202)
2. Viscosity @ 275°F, Kinematic, (AASHTO T201)
3. Penetration @77°F, (AASHTO T49)
4. Ductility @ 39.2°F, (AASHTO T51)
5. Flash Point, Cleveland Open Cup, (AASHTO T48)
6. Solubility in Trichloroethylene, (AASHTO T44)
7. % Loss on Thin Film Oven Test Residue, (AASHTO T179)
8. Penetration @77°F on Thin Film Oven Test Residue (AASHTO T49)
9. Penetration @ 77°F Ratio (% of Original) between the Thin Film Oven Test Residue and the Penetration @ 77°F on the original sample.
10. Viscosity @ 140°F, Absolute on Thin Film Oven Test Residue (AASHTO T202)
11. Ductility @ 77°F on Thin Film Oven Test Residue (AASHTO T51)

B. Additional tests not required by Department of Transportation Specifications:

1. Penetration @ 39.2°F (AASHTO T49)
2. Penetration Ratio: 39.2°F/77°F
3. Ductility @ 77°F, (AASHTO T51)
4. Specific Gravity @ 77°F (AASHTO T228)
5. Softening Point, Ethylene Glycol (AASHTO T53)
6. Viscosity @ 275°F, Kinematic, on Thin Film Oven Test Residue (AASHTO T201)
7. Ductility @ 60°F on Thin Film Oven Test Residue (AASHTO T51)
8. Viscosity @ 140°F, Absolute, Ratio, between viscosity @ 140°F, Absolute on Thin Film Oven Test Residue Sample and the original sample.
9. A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes.
10. Chemical Analysis of asphalt cement.

C. A Penetration Viscosity Number (PVN) and a Penetration Index Number (PIN) has been computed for each asphalt cement sample.

IV. Test Data and Sample Identification Forms

On the following pages are the Standard Test Report and Sample Identification Forms used for this project.

PRIMARY SOURCE	LOCATION
CRUDE SOURCE	SAMPLED AT
SAMPLED BY	DATE SAMPLED
ITEM NO.	GRADE TYPE
LOT NO.	DATE OF CERTIFICATION

REMARKS:

NEW YORK STATE

DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
1985 ASPHALT MONITOR PROGRAM

	TEST NO.
PRIMARY SOURCE	LOCATION

LOT NO.	ITEM NO.	GRADE TYPE

CRUDE SOURCE	AASHTO	RESULTS
1. Viscosity Ratio @ 140 F		
a.) Viscosity of Original Sample, (poises)	T 202	
2. Viscosity @ 275 F, Centistokes	T 202	
3. Penetration @ 77 F, 100g., 5 sec.	T 201	
4. Penetration @ 39.2 F, 200g., 60 sec.	T 49	
5. Penetration Ratio (39.2°F/77°F) 100		
6. Ductility @ 39.2 F, 1 cm/min., cm.	T 51	
7. Ductility @ 77 F, 5cm/min., cm.	T 51	
8. Flash Point C.O.C., F	T 48	
9. Solubility in Trichloroethylene	T 44	
10. Loss on Heating T.F.O.T., Percent, 325F @ 5 Hrs.	T 179	
11. Specific Gravity @ 77 F	T 228	
12. Ductility @ 60 F, T.F.O.T., 5cm/min., cm.	T 51	
13. Ductility @ 77 F, T.F.O.T., 5cm/min., cm.	T 51	
14. Penetration @ 77 F, T.F.O.T., 100g., 5 sec.	T 49	
a.) Percent of Original		
15. Viscosity @ 275 F After T.O.F.T. (cst)	T 201	
16. Penetration Viscosity Number, PVN		
17. Softening Point, Ethylene Glycol, °F	T 53	
18. Penetration Index Number, PIN		

NEW YORK STATE

DEPARTMENT OF TRANSPORTATION

MATERIALS BUREAU

1985 ASPHALT MONITOR PROGRAM

	TEST NO.
PRIMARY SOURCE	LOCATION

LOT NO.	ITEM NO.	GRADE TYPE

CRUDE SOURCE

ASPHALT COMPOSITION ANALYSIS

ASPHALTENES, %	
SATURATES, %	
NAPHTHENE AROMATICS, %	
POLAR AROMATICS, %	

A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes

SETTLEMENT TIME, MINUTES	

V. NEW YORK STATE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR ASPHALT CEMENT

TABLE 702-1

ASPHALT CEMENTS FOR PAVING

MATERIAL DESIGNATION	702-0100		702-0200		702-0300		702-0400		702-0500	
VISCOSITY GRADE	AC-2.5		AC -5		AC-10		AC-15		AC-20	
Test Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity 140 F (60 C), P	200	300	400	600	800	1200	1200	1800	1600	2400
Viscosity 275F(135 C), cSt	125		175		250		275		300	
Penetration 77F (25C),100g, 5s	200	325	120	200	70	120	60	100	60	100
Flash Point COC, F(C)	325(163)		350(177)		425(219)		435(225)		450(232)	
Solubility in Trichloroethylene, %	99.0		99.0		99.0		99.0		99.0	
Tests on Residue from Thin Film Oven Test										
Viscosity, 140 F(60C), P		1250		2500		5000		7500		10,000
Ductility, 77 F(25C) 5 cm/min., cm	100		100		75		60		50	
TYPICAL USES (intended only as a general information guide)	Recyle Mix		Hot plant mix very cold climate. Recycle Mix.		Hot plant mix cold climate. Recycle Mix.		Hot plant mix moderate climate.		Hot plant mix moderate climate. Sheet mixes. Open graded surface course mixes.	

TABLE 702-2

MISCELLANEOUS ASPHALT CEMENTS

MATERIAL DESIGNATION	702-0600	
GRADE	85/100	
TEST REQUIREMENTS	Min	Max
Penetration,77F(25C), 100g, 5s	85	100
Viscosity,275F(135C), cSt	280	
Flash Point, COC, F	450	
Solubility in trichloroethylene, %	99.5	
Ductility, 39.2F(4C), 1cm/min., cm	6	
Tests on residue from Thin-film Oven Test (AASHTO T179)		
Loss on Heating, 325F, 5h, %		.85
Penetration, % original	47	
Ductility, 77F(25C), 5cm/min., cm	75	
Typical Uses	Hot plant mix moderate climate	

SPECIFICATION
CHEVRON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	600	800
Viscosity, 275F(135C), cst	200	-
Penetration, 77F(25C), 100g., 5 sec.	140	190
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	3200
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
CIBRO
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	800	1200
Viscosity, 275F(135F), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	125	175
Flash Point, C.O.C., F	400	--
Solubility in Trichloroethylene, %	99.0	-
Test on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	4000
Ductility, 77F(25C), 5cm/min., cm.	75	-

SPECIFICATION
MARATHON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	400	600
Viscosity, 275F(135C), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	175	225
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
UNITED REFINING
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	300	500
Viscosity, 275F(135C), cst	125	-
Penetration, 77F(25C), 100g., 5 sec.	150	200
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

VI. Summary of Test Results

Test results for all twenty-two asphalt cement samples met New York State Department of Transportation Specification requirements. The following exceptions are noted below:

A. Marathon, Tonawanda, NY

FLUX	Lot 3	Mid Continent and Canadian
Penetration @ 77°F,		172
Specification:		175 to 225

B. United Refining, Warren, PA

FLUX	Lot 43	Canadian
Solubility in Trichloroethylene		98.73%
Specification:		99.0% minimum

C. Petro Canada, Oakville, Ont.

#702-0200, AC-5,	Lot 332	Bow River
Viscosity @ 140°F,	Absolute	653 poises
Specification:	400 to 600 poises	

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediately to the left.

1985 ASPHALT CEMENT MONITOR PROGRAM			ABSOLUTE		KINEMATIC						PENETRATION	
		CRUDE	VISCOSITY	COMPARATIVE	VISCOSITY	COMPARATIVE	PENETRATION	COMPARATIVE	PENETRATION	COMPARATIVE	RATIO	COMPARATIVE
AC	SUPPLIER - LOCATION - LOT	SOURCE	@ 140°F	RESULTS	@ 275°F	RESULTS	@ 77°F	RESULTS	@ 39.2°F	RESULTS	39.2°/77°F	RESULTS
FLUX	CHEVRON, PERTH AMBOY 15	MEXICO MAYAN	696	698	280	270	181	179	64	*	35.4	*
FLUX	CIBRO, ALBANY 56	BOSCAN	1137	1027	354	343	137	141	48	*	35.0	*
FLUX	GULF CAN., MISS., ONTARIO -	W. CANADIAN	666	700	249	235	163	166	50	52	30.7	31.3
FLUX	MARATHON, TONAWANDA 3	MID-CONT. & CANADIAN	559	595	229	219	172	177	50	50	29.1	28.2
FLUX	UNITED REF., WARREN, PA. 43	CANADIAN	328	313	146	275	158	159	35	39	22.2	24.5
	$\bar{X}$		677	667	252	268	162	164	49	47	30.5	28.0
	σ		294.9	256.0	75.8	47.9	16.6	15.4	10.3	7.0	5.4	3.4
5	PETRO-CAN., OAKVILLE 332	BOW RIVER	653	670	246	241	155	157	43	*	27.7	*
15	GULF CAN., MISS., ONTARIO 85/28	W. CANADIAN	1557	1528	371	356	87	93	28	27	32.2	29.0
15	MARATHON, TONAWANDA 19	MID-CONT. & CANADIAN	1494	1528	353	345	83	88	27	28	32.5	31.8
15	NO CO ENERGY, TONAWANDA 6	BOW RIVER CANADIAN	1329	1387	343	*	89	91	28	*	31.5	*
15	PETRO-CAN., OAKVILLE 330	BOW RIVER	1422	1460	353	346	92	97	29	*	31.5	*
15	UNITED REF., WARREN, PA. 44	CANADIAN	1435	1385	305	289	63	65	17	17	27.0	26.2
15	WARDEN, PITTSFORD 190	CANADIAN	1485	1449	322	*	64	65	20	*	31.3	*
	$\bar{X}$		1454	1456	341	334	80	83	25	24	31.0	29.0
	σ		77.7	63.6	23.9	30.4	12.9	14.4	5.0	6.1	2.0	2.8
20	ARCO, PHILADELPHIA 3A	NORTH SLOPE, MAYA, VENZ.	2010	1983	416	401	72	78	26	38	36.1	48.7
20	CHEVRON, PERTH AMBOY 14	VEN. BOSCAN, PILON	2115	2116	463	458	82	82	31	*	37.8	*
20	CIBRO, ALBANY 53	BACHACARO	2114	1964	381	351	72	72	23	*	31.9	*
20	EXXON, LINDEN, N.J. 13	MAYA/NO. SLOPE	1961	2078	408	390	70	70	23	*	32.9	*
20	MARATHON, TONAWANDA 20	MID-CONT. & CANADIAN	1915	1962	400	390	69	69	22	21	31.9	30.4
20	PECKHAM, STAMFORD 29	-	2176	2104	449	*	77	78	27	*	35.1	*
20	WEST BANK, P. AMBOY 11	VENEZUELAN	2254	2206	454	458	76	79	27	28	35.5	35.4
	$\bar{X}$		2078	2059	424	408	74	75	26	29	34.5	38.2
	σ		121.2	92.6	31.1	42.3	4.6	5.0	3.2	8.5	2.3	9.5
85/100	GULF CAN., MONTREAL 58	MEXICAN	1201	1255	318	312	91	92	30	39	33.0	42.4
85/100	PETRO CAN., MONTREAL 1	MEX. MENEMOTA, VENEZUELAN	1373	1365	319	338	86	86	28	30	32.6	34.9
85/100	SHELL CAN., MONTREAL 85/9	CANADIAN, MEXICAN & VARIOUS	1267	1255	319	294	87	88	31	*	35.6	*
	$\bar{X}$		1280	1292	319	315	88	89	30	35	33.7	38.7
	σ		86.8	63.5	0.6	22.1	2.6	3.1	1.5	6.4	1.6	5.3
	* RESULTS NOT GIVEN											

1985 ASPHALT CEMENT MONITOR PROGRAM AC	Supplier - Location - Lot	Crude Source	T.F.O.T. Loss %	Comparative Results	T.F.O.T. Ductility @ 60°F	Comparative Results	T.F.O.T. Ductility @ 77°F	Comparative Results	T.F.O.T. Viscosity @ 140°F	Comparative Results	T.F.O.T. Viscosity Ratio	Comparative Results
FLUX	Chevron, Perth Amboy 15	Mexico Mayan	1.462	1.410	112.25	*	150.0+	125.0+	3084	*	4.43	*
FLUX	Cibro, Albany 56	Boscan	1.302	1.100	150.0+	*	150.0+	*	3799	3710	3.34	3.60
FLUX	Gulf Can., Miss., Ontario –	W. Canadian	0.314	0.232	150.0+	150.0+	150.0+	150.0+	1448	2032	2.17	2.90
FLUX	Marathon, Tonawanda 3	Mid-Cont. & Canadian	0.302	0.330	150.0+	150.0+	150.0+	150.0+	1327	1447	2.37	2.43
FLUX	United Ref., Warren, Pa. 43	Canadian	+0.066 gain	+0.030 gain	150.0+	120.0+	123.0	120.0+	620	574	1.89	1.83
	$\bar{X}$		0.676	0.614	142.5		144.6		2056	1941	2.84	2.69
	σ		0.659	0.607	16.9		12.1		1328.3	1322.9	1.04	0.75
5	Petro-Can., Oakville 332	Bow River	+0.016 gain	0.005	150.0+	*	150.0+	*	1324	1525	2.03	2.28
15	Gulf Can., Miss., Ontario 85/28	W. Canadian	0.191	0.095	150.0+	150.0+	150.0+	150.0+	3684	4115	2.37	2.69
15	Marathon, Tonawanda 19	Mid-Cont. & Canadian	0.125	0.100	150.0+	150.0+	150.0+	150.0+	3208	3142	2.15	2.06
15	No Co Energy, Tonawanda 6	Bow River, Canadian	0.051	*	150.0+	*	150.0+	*	2912	*	2.19	*
15	Petro-Can., Oakville 330	Bow River	+0.007 gain	0.015	150.0+	*	150.0+	*	3064	4292	2.15	2.94
15	United Ref., Warren, Pa. 44	Canadian	0.612	+0.020 gain	22.0	25.0	150.0+	120.0+	4148	3534	2.89	2.55
15	Warden, Pittsford 190	Canadian	0.338	*	18.25	*	150.0+	*	3763	*	2.53	*
	$\bar{X}$		0.220	0.053	106.7	108.3	150.0+		3463	3771	2.38	2.56
	σ		0.226	0.052	67.1	72.2	—		476.6	529.6	0.29	0.37
20	Arco, Philadelphia 3A	North Slope, Maya, Venz.	0.082	0.071	39.50	37.0	150.0+	*	5129	5064	2.55	2.55
20	Chevron, Perth Amboy 14	Ven. Boscan, Pilon	0.435	0.500	44.75	*	150.0+	125.0+	7081	7188	3.35	3.40
20	Cibro, Albany 53	Bachacaro	0.545	0.380	28.25	*	150.0+	*	4948	4123	2.34	2.10
20	Exxon, Linden, N.J. 13	Maya/No. Slope	0.159	0.030	33.50	41.0	150.0+	150.0+	4409	4740	2.25	2.28
20	Marathon, Tonawanda 20	Mid-Cont. & Canadian	0.113	0.110	73.0	132.0	150.0+	150.0+	4456	4097	2.33	2.09
20	Peckham, Stamford 29	—	0.394	*	33.75	*	150.0+	*	6284	*	2.89	*
20	West Bank, P. Amboy 11	Venezuelan	0.321	0.286	74.25	68.0	150.0+	100.0+	5973	6673	2.65	3.02
	$\bar{X}$		0.293	0.230	46.7	69.5	150.0+		5469	5314	2.62	2.57
	σ		0.178	0.189	19.1	43.9	—		1004.5	1315.3	0.39	0.53
85/100	Gulf Can., Montreal 58	Mexican	+0.013 gain	0.010	31.25	*	150.0+	150.0+	3439	3286	2.86	2.62
85/100	Petro Can., Montreal 1	Mex. Menemota, Venezuelan	0.053	0.030	29.25	106.0	106.25	125.0+	3527	2990	2.57	2.19
85/100	Shell Can., Montreal 85/9	Canadian, Mexican & Various	+0.030 gain	+0.040 gain	9.25	*	150.0+	110.0+	4526	5187	3.57	4.13
	$\bar{X}$		0.018	0.013	23.3		135.4		3831	3821	3.00	2.98
	σ		0.031	0.015	12.2		25.3		603.8	1192.2	0.51	1.02
	*Results Not Given											

1985 ASPHALT CEMENT MONITOR PROGRAM			T.F.O.T.		T.F.O.T.		T.F.O.T.		SPECIFIC		C.O.C.	
AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	VISCOSITY @275°F	COMPARATIVE RESULTS	PENETRATION @77°F	COMPARATIVE RESULTS	PENETRATION RATIO	COMPARATIVE RESULTS	GRAVITY @77°F	COMPARATIVE RESULTS	FLASH POINT, °F	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY 15	MEXICO MAYAN	531	*	75	*	41.4	*	1.025	1.023	555	470
FLUX	CIBRO, ALBANY 56	BOSCAN	616	617	69	64	50.4	45.4	1.029	1.033	455	445
FLUX	GULF CAN., MISS., ONTARIO —	W. CANADIAN	342	389	96	84	58.9	50.6	1.022	1.024	525	560
FLUX	MARATHON, TONAWANDA 3	MID-CONT. & CANADIAN	318	318	91	95	52.9	53.7	1.019	1.019	540	560
FLUX	UNITED REF., WARREN, PA. 43	CANADIAN	170	178	95	102	60.1	64.2	1.005	1.003	620	630
	$\bar{X}$		395	376	85	86	52.7	53.5	1.020	1.020	539	533
	σ		178.0	183.3	12.4	16.6	7.5	7.9	0.009	0.011	59.3	75.1
5	PETRO-CAN., OAKVILLE 332	BOW RIVER	336	*	91	90	58.7	57.3	1.019	1.023	570	597
15	GULF CAN., MISS., ONTARIO 85/28	W. CANADIAN	533	511	53	55	60.9	59.1	1.027	1.028	550	540
15	MARATHON, TONAWANDA 19	MID-CONT. & CANADIAN	492	465	53	55	63.9	62.5	1.026	1.026	595	600
15	NO CO ENERGY, TONAWANDA 6	BOW RIVER CANADIAN	469	*	56	*	62.9	*	1.024	*	585	*
15	PETRO-CAN., OAKVILLE 330	BOW RIVER	490	*	58	56	63.0	57.7	1.025	1.030	565	608
15	UNITED REF., WARREN, PA. 44	CANADIAN	463	424	33	38	52.4	58.5	1.015	1.020	555	625
15	WARDEN, PITTSFORD 190	CANADIAN	455	*	36	*	56.3	*	1.016	*	585	*
	$\bar{X}$		484	467	48	51	59.9	59.5	1.022	1.026	573	593
	σ		28.3	43.5	10.8	8.7	4.6	2.1	0.005	0.004	18.4	37.0
20	ARCO, PHILADELPHIA 3A	NORTH SLOPE, MAYA, VENZ.	611	*	45	48	62.5	61.5	1.029	1.026	635	615
20	CHEVRON, PERTH AMBOY 14	VEN. BOSCAN, PILON	801	*	46	*	56.1	*	1.032	1.030	530	510
20	CIBRO, ALBANY 53	BACHACARO	560	518	44	47	61.1	65.3	1.027	1.034	520	505
20	EXXON, LINDEN, N.J. 13	MAYA/NO. SLOPE	598	*	45	*	64.3	*	1.027	1.027	640	550+
20	MARATHON, TONAWANDA 20	MID-CONT. & CANADIAN	555	518	44	48	63.8	69.6	1.028	1.028	595	600+
20	PECKHAM, STAMFORD 29	—	702	*	44	*	57.1	*	1.025	*	545	*
20	WEST BANK, P. AMBOY 11	VENEZUELAN	691	677	47	47	61.8	59.5	1.023	1.022	565	560
	$\bar{X}$		645	571	45	48	61.0	64.0	1.027	1.028	576	
	σ		89.8	91.8	1.2	0.6	3.2	4.5	0.003	0.004	48.8	
85/100	GULF CAN., MONTREAL 58	MEXICAN	511	463	52	55	57.1	59.8	1.025	1.025	565	560
85/100	PETRO CAN., MONTREAL 1	MEX. MENEMOTA, VENEZUELAN	508	419	52	55	60.5	64.0	1.021	1.022	575	590
85/100	SHELL CAN., MONTREAL 85/9	CANADIAN, MEXICAN & VARIOUS	508	*	50	58	57.5	65.9	1.021	1.021	605	669
	$\bar{X}$		509	441	51	56	58.4	63.2	1.022	1.023	582	606
	σ		1.7	31.1	1.2	1.7	1.9	3.1	0.002	0.002	20.8	56.3

* RESULTS NOT GIVEN

1985 ASPHALT CEMENT MONITOR PROGRAM													
AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	DUCTILITY @ 39.2°F	COMPARATIVE RESULTS	DUCTILITY @ 77°F	COMPARATIVE RESULTS	SOLUBILITY %	COMPARATIVE RESULTS	SOFTENING POINT, °F	COMPARATIVE RESULTS	PVN	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY 15	MEXICO MAYAN	150.0+	*	150.0+	*	99.99	99.21	110	*	-0.048	-0.126
FLUX	CIBRO, ALBANY 56	BOSCAN	150.0+	*	150.0+	*	99.99	99.98	114	*	-0.025	-0.039
FLUX	GULF CAN., MISS., ONTARIO —	W. CANADIAN	150.0+	100.0+	150.0+	150.0+	99.99	99.97	105	105	-0.388	-0.463
FLUX	MARATHON, TONAWANDA 3	MID-CONT. & CANADIAN	150.0+	15.0+	150.0+	150.0+	99.99	99.98	107	108	-0.462	-0.503
FLUX	UNITED REF., WARREN, PA. 43	CANADIAN	150.0+	*	150.0+	120.0+	98.73	*	115	137	-1.327	-0.251
	$\bar{X}$		150.0+		150.0+		99.74	99.79	110	117	-0.450	-0.276
	σ		—		—		0.56	0.38	4.3	17.7	0.528	0.204
5	PETRO-CAN., OAKVILLE 332	BOW RIVER	150.0+	15.0+	141.0	150.0+	99.99	99.90	110	*	-0.471	-0.490
15	GULF CAN., MISS., ONTARIO 85/28	W. CANADIAN	86.50	53.0	150.0+	150.0+	99.99	99.96	118	120	-0.495	-0.483
15	MARATHON, TONAWANDA 19	MID-CONT. & CANADIAN	61.0	12.0	150.0+	150.0+	99.98	99.96	116	118	-0.620	-0.591
15	NO CO ENERGY, TONAWANDA 6	BOW RIVER CANADIAN	88.50	*	150.0+	*	99.97	*	115	*	-0.587	*
15	PETRO-CAN., OAKVILLE 330	BOW RIVER	61.25	15.0+	150.0+	150.0+	99.96	99.90	115	*	-0.508	-0.479
15	UNITED REF., WARREN, PA. 44	CANADIAN	7.25	*	150.0+	120.0+	99.18	*	121	152	-1.107	-1.154
15	WARDEN, PITTSFORD 190	CANADIAN	8.0	*	150.0+	*	99.22	*	118	*	-1.015	*
	$\bar{X}$		52.1		150.0+		99.72	99.94	117	130	-0.722	-0.677
	σ		36.4		—		0.40	0.03	2.3	19.1	0.268	0.322
20	ARCO, PHILADELPHIA 3A	NORTH SLOPE, MAYA, VENZ.	16.50	*	150.0+	100.0+	99.99	99.91	120	*	-0.530	-0.498
20	CHEVRON, PERTH AMBOY 14	VEN. BOSCAN, PILON	18.75	*	150.0+	*	99.99	99.62	121	*	-0.231	-0.247
20	CIBRO, ALBANY 53	BACHACARO	150.0+	*	150.0+	*	99.99	99.99	119	*	-0.658	-0.776
20	EXXON, LINDEN, N.J. 13	MAYA/NO. SLOPE	14.50	*	150.0+	*	99.97	99.99	123	*	-0.588	-0.653
20	MARATHON, TONAWANDA 20	MID-CONT. & CANADIAN	19.75	15.0+	150.0+	150.0+	99.99	99.94	121	125	-0.631	-0.668
20	PECKHAM, STAMFORD 29	—	26.50	*	150.0+	*	99.99	*	122	*	-0.347	*
20	WEST BANK, P. AMBOY 11	VENEZUELAN	40.0	15.0	150.0+	100.0+	99.99	99.75	122	117	-0.345	-0.289
	$\bar{X}$		40.9		150.0+		99.99	99.87	121	121	-0.476	-0.522
	σ		48.9		—		0.01	0.15	1.3	5.7	0.167	0.216
85/100	GULF CAN., MONTREAL 58	MEXICAN	24.0	*	150.0+	150.0+	99.88	*	118	117	-0.678	-0.695
85/100	PETRO CAN., MONTREAL 1	MEX. MENEMOTA, VENEZUELAN	37.75	25.0+	150.0+	140.0+	99.98	99.82	119	115	-0.733	-0.647
85/100	SHELL CAN., MONTREAL 85/9	CANADIAN, MEXICAN & VARIOUS	11.25	9.50	150.0+	150.0+	99.67	99.90	122	*	-0.721	-0.831
	$\bar{X}$		24.3		150.0+		99.84	99.86	120	116	-0.711	-0.724
	σ		13.3		—		0.16	0.06	2.1	1.4	0.029	0.095
	* RESULTS NOT GIVEN											

1985 ASPHALT CEMENT MONITOR PROGRAM AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	PIN	COMPARATIVE RESULTS	SETTLEMENT TEST MINUTES	ASPHALTENES %	SATURATES %	% NAPHTHENE AROMATICS	% POLAR AROMATICS
FLUX	CHEVRON, PERTH AMBOY 15	MEXICO MAYAN	+0.869	*	24.4	16.6	8.7	27.6	37.8
FLUX	CIBRO, ALBANY 56	BOSCAN	+0.474	*	25.0	16.1	6.5	28.3	39.8
FLUX	GULF CAN., MISS., ONTARIO —	W. CANADIAN	-0.685	-0.611	20.8	13.4	11.6	30.6	40.1
FLUX	MARATHON, TONAWANDA 3	MID-CONT. & CANADIAN	-0.009	+0.338	53.5	11.9	11.0	29.9	41.0
FLUX	UNITED REF., WARREN, PA. 43	CANADIAN	+1.243	+4.616	55.7	7.6	8.6	34.2	37.5
	$\bar{X}$		0.378	1.448	35.9	13.1	9.3	30.1	39.2
	σ		0.755	2.785	17.2	3.6	2.1	2.6	1.5
5	PETRO-CAN., OAKVILLE 332	BOW RIVER	+0.191	*	33.1	11.9	11.9	29.7	40.4
15	GULF CAN., MISS., ONTARIO 85/28	W. CANADIAN	-0.370	+0.148	22.3	15.3	10.2	29.9	40.5
15	MARATHON, TONAWANDA 19	MID-CONT. & CANADIAN	-0.828	-0.336	49.6	13.3	14.0	25.2	43.6
15	NO CO ENERGY, TONAWANDA 6	BOW RIVER CANADIAN	-0.794	*	32.1	11.9	9.6	29.8	39.5
15	PETRO-CAN., OAKVILLE 330	BOW RIVER	-0.697	*	19.3	13.8	10.4	28.2	39.0
15	UNITED REF., WARREN, PA. 44	CANADIAN	-0.791	+2.997	66.3	8.8	8.2	33.9	39.7
15	WARDEN, PITTSFORD 190	CANADIAN	-1.197	*	60.7	9.7	9.4	32.4	40.5
	$\bar{X}$		-0.780	0.936	41.7	12.1	10.3	29.9	40.5
	σ		0.265	1.801	20.0	2.5	2.0	3.1	1.6
20	ARCO, PHILADELPHIA 3A	NORTH SLOPE, MAYA, VENZ.	-0.592	*	29.8	18.5	10.4	31.2	37.8
20	CHEVRON, PERTH AMBOY 14	VEN. BOSCAN, PILON	-0.078	*	26.8	17.9	7.5	27.4	39.5
20	CIBRO, ALBANY 53	BACHACARO	-0.743	*	62.7	12.7	9.3	31.5	37.4
20	EXXON, LINDEN, N.J. 13	MAYA/NO. SLOPE	-0.228	*	38.2	15.0	9.4	27.1	39.5
20	MARATHON, TONAWANDA 20	MID-CONT. & CANADIAN	-0.557	+0.015	54.3	13.2	13.4	26.4	41.7
20	PECKHAM, STAMFORD 29	—	-0.109	*	58.8	15.0	8.8	29.3	37.9
20	WEST BANK, P. AMBOY 11	VENEZUELAN	-0.146	-0.804	84.3	14.4	8.2	30.1	37.5
	$\bar{X}$		-0.350	-0.395	50.7	15.2	9.6	29.0	38.8
	σ		0.272	0.579	20.5	2.2	1.9	2.1	1.6
85/100	GULF CAN., MONTREAL 58	MEXICAN	-0.235	-0.364	38.8	17.1	11.7	32.6	33.6
85/100	PETRO CAN., MONTREAL 1	MEX. MENEMOTA, VENEZUELAN	-0.246	-0.893	73.8	15.0	12.2	32.2	35.5
85/100	SHELL CAN., MONTREAL 85/9	CANADIAN, MEXICAN & VARIOUS	+0.249	*	39.7	16.6	13.5	30.6	34.5
	$\bar{X}$		-0.077	-0.629	50.8	16.2	12.5	31.8	34.5
	σ		0.283	0.374	20.0	1.1	0.9	1.1	1.0

* RESULTS NOT GIVEN

Only one supplier submitted Asphalt Composition Analysis Results to the Materials Bureau.

Petro-Canada, Montreal, Quebec

85/100 Lot 1 Mexican, Menemota (Venezuelan)

Asphalt Composition Analysis

85/100

	Materials Bureau	Petro Canada
% Asphaltenes,	15.04	13.4
% Saturates,	12.15	14.3
% Naphthene Aromatics,	32.15	23.6
% Polar Aromatics,	35.49	43.6

VIII. Statistical Analysis of Test Results

The mean, range and standard deviation were determined for the number of samples tested in each grade of asphalt cement. For each test, this statistical information has been determined separately for the Materials Bureau results and when applicable, the comparable results submitted by the supplier.

A. ABSOLUTE VISCOSITY @ 140°F (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	677	-	1454	2078	1280
Range	328 to 1137	-	1329 to 1557	1915 to 2254	1201 to 1373
Standard Deviation	294.9	-	77.7	121.2	86.8

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	667	-	1456	2059	1292
Range	313 to 1027	-	1385 to 1528	1962 to 2206	1255 to 1365
Standard Deviation	256.0	-	63.6	92.6	63.5

B. KINEMATIC VISCOSITY @ 275°F (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	252	-	341	424	319
Range	146 to 354	-	305 to 371	381 to 463	318 to 319
Standard Deviation	75.8	-	23.9	31.1	0.6

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	4	6	3
Mean	268	-	334	408	315
Range	219 to 343	-	289 to 356	351 to 458	294 to 338
Standard Deviation	47.9	-	30.4	42.3	22.1

C. PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	162	-	80	74	88
Range	137 to 181	-	63 to 92	69 to 82	86 to 91
Standard Deviation	16.6	-	12.9	4.6	2.6

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	164	-	83	75	89
Range	141 to 179	-	65 to 97	69 to 82	86 to 92
Standard Deviation	15.4	-	14.4	5.0	3.1

D. PENETRATION @ 39.2°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	49	-	25	26	30
Range					
Standard Deviation	10.3	-	5.0	3.2	1.5

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	-	3	3	2
Mean	47	-	24	29	35
Range	39 to 52	-	17 to 28	21 to 38	30 to 39
Standard Deviation	7.0	-	6.1	8.5	6.4

E. PENETRATION RATIO

(PENETRATION @ 39.2°F divided by PENETRATION @ 77°F X 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	30.5	-	31.0	34.5	33.7
Range	22.2 to 35.4	-	27.0 to 32.5	31.9 to 37.8	32.6 to 35.6
Standard Deviation	5.4	-	2.0	2.3	1.6

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	-	3	3	2
Mean	28.0	-	29.0	38.2	38.7
Range	24.5 to 31.3	-	26.2 to 31.8	30.4 to 48.7	34.9 to 42.4
Standard Deviation	3.4	-	2.8	9.5	5.3

F. THIN FILM OVEN TEST, % LOSS

(SAMPLES WHICH SHOWED WEIGHT GAINS WERE CALCULATED AS 0.000% LOSS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	0.676	-	0.220	0.293	0.018
Range	0.000 to 1.462	-	0.000 to 0.612	0.082 to 0.545	0.000 to 0.053
Standard Deviation	0.659	-	0.226	0.178	0.031

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	4	6	3
Mean	0.614	-	0.053	0.230	0.013
Range	0.000 to 1.410	-	0.000 to 0.100	0.030 to 0.500	0.000 to 0.030
Standard Deviation	0.607	-	0.052	0.189	0.015

G. THIN FILM OVEN TEST, DUCTILITY @ 60°F, 5cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	142.5	-	106.7	46.7	23.3
Range	112.25 to 150.0+	-	18.25 to 150.0	28.25 to 74.25	9.25 to 31.25
Standard Deviation	16.9	-	67.1	19.1	12.2

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	-	3	4	1
Mean	-	-	108.3	69.5	-
Range	120.0+ to 150.0+	-	25.0 to 150.0+	37.0 to 132.0	-
Standard Deviation	-	-	72.2	43.9	-

H. THIN FILM OVEN TEST, DUCTILITY @ 77°F, 5cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	144.6	-	150.0+	150.0+	135.4
Range	123.0 to 150.0+	-	-	-	106.25 to 150.0+
Standard Deviation	12.1	-	-	-	25.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	-	3	4	3
Mean	-	-	-	-	-
Range	120.0+ to 150.0+	-	120.0+ to 150.0+	100.0+ to 150.0+	110.0+ to 150.0+
Standard Deviation	-	-	-	-	-

I. THIN FILM OVEN TEST, ABSOLUTE VISCOSITY @ 140°F, (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	2056	-	3463	5469	3831
Range	620 to 3799	-	2912 to 4148	4409 to 7081	3439 to 4526
Standard Deviation	1328.3	-	476.6	1004.5	603.8

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	1	4	6	3
Mean	1941	-	3771	5314	3821
Range	574 to 3710	-	3142 to 4292	4097 to 7188	2990 to 5187
Standard Deviation	1322.9	-	529.6	1315.3	1192.2

J. ABSOLUTE VISCOSITY @140°F RATIO

(AFTER T.F.O.T. VISCOSITY @ 140°F DIVIDED BY ORIGINAL VISCOSITY @ 140°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	2.84	-	2.38	2.62	3.00
Range	1.89 to 4.43	-	2.15 to 2.89	2.25 to 3.35	2.57 to 3.57
Standard Deviation	1.04	-	0.29	0.39	0.51

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	1	4	6	3
Mean	2.69	-	2.56	2.57	2.98
Range					
Standard Deviation	0.75	-	0.37	0.53	1.02

K. THIN FILM OVEN TEST, KINEMATIC VISCOSITY @ 275°F, (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	395	-	484	645	509
Range	170 to 616	-	455 to 533	555 to 801	508 to 511
Standard Deviation	178.0	-	28.3	89.8	1.7

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	-	3	3	2
Mean	376	-	467	571	441
Range	178 to 617	-	424 to 511	518 to 677	419 to 463
Standard Deviation	183.3	-	43.5	91.8	31.1

L. THIN FILM OVEN TEST, PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	85	-	48	45	51
Range	69 to 96	-	33 to 58	44 to 47	50 to 52
Standard Deviation	12.4	-	10.8	1.2	1.2

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	1	4	4	3
Mean	86	-	51	48	56
Range	64 to 102	-	38 to 56	47 to 48	55 to 58
Standard Deviation	16.6	-	8.7	0.6	1.7

M. PENETRATION @ 77°F RATIO,

(AFTER T.F.O.T. PENETRATION @77°F DIVIDED BY ORIGINAL PENETRATION @ 77°F X 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	52.7	-	59.9	61.0	58.4
Range	41.4 to 60.1	-	52.4 to 63.9	56.1 to 64.3	57.1 to 60.5
Standard Deviation	7.5	-	4.6	3.2	1.9

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	1	4	4	3
Mean	53.5	-	59.5	64.0	63.2
Range	45.4 to 64.2	-	57.7 to 62.5	59.5 to 69.6	59.8 to 65.9
Standard Deviation	7.9	-	2.1	4.5	3.1

N. SPECIFIC GRAVITY @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	1.020	-	1.022	1.027	1.022
Range	1.005 to 1.029	-	1.015 to 1.027	1.023 to 1.032	1.021 to 1.025
Standard Deviation	0.009	-	0.005	0.003	0.002

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	4	6	3
Mean	1.020	-	1.026	1.028	1.023
Range	1.003 to 1.033	-	1.020 to 1.030	1.022 to 1.034	1.021 to 1.025
Standard Deviation	0.011	-	0.004	0.004	0.002

O. FLASH POINT, CLEVLAND OPEN CUP, °F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	539	-	573	576	582
Range	455 to 620	-	550 to 595	520 to 640	565 to 605
Standard Deviation	59.3	-	18.4	48.8	20.8

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	4	6	3
Mean	533	-	593	-	606
Range	445 to 630	-	540 to 625	505 to 600+	560 to 669
Standard Deviation	75.1	-	37.0	-	56.3

P. DUCTILITY @ 39.2°F, 1cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	150.0+	-	52.1	40.9	24.3
Range	-	-	7.25 to 88.50	14.50 to 150.0+	11.25 to 37.75
Standard Deviation	-	-	36.4	48.9	13.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	2	1	3	2	2
Mean	-	-	-	-	-
Range	15.0+ to 100.0+	-	12.0 to 15.0+	15.0 to 15.0+	9.50 to 25.0+
Standard Deviation	-	-	-	-	-

Q. DUCTILITY @ 77°F, 5cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	150.0+	-	150.0+	150.0+	150.0+
Range	-	-	-	-	-
Standard Deviation	-	-	-	-	-

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	1	4	3	3
Mean	-	-	-	-	-
Range	120.0+ to 150.0+	-	120.0+ to 150.0+	100.0+ to 150.0+	140.0+ to 150.0+
Standard Deviation	-	-	-	-	-

R. SOLUBILITY IN TRICHLOROETHYLENE, (%)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	99.74	-	99.72	99.99	99.84
Range	98.73 to 99.99	-	99.18 to 99.99	99.97 to 99.99	99.67 to 99.98
Standard Deviation	0.56	-	0.40	0.01	0.16

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	4	1	3	6	2
Mean	99.79	-	99.94	99.87	99.86
Range	99.21 to 99.98	-	99.90 to 99.96	99.62 to 99.99	99.82 to 99.90
Standard Deviation	0.38	-	0.03	0.15	0.06

S. SOFTENING POINT, ETHYLENE GLYCOL, (°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	110	-	117	121	120
Range	105 to 115	-	115 to 121	119 to 123	118 to 122
Standard Deviation	4.3	-	2.3	1.3	2.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	-	3	2	2
Mean	117	-	130	121	116
Range	105 to 137	-	118 to 152	117 to 125	115 to 117
Standard Deviation	17.7	-	19.1	5.7	1.4

T. Penetration Viscosity Number, (PVN)

The penetration viscosity number, PVN, is an indicator of the temperature susceptibility of asphalt cements. Lower PVN indicates greater temperature susceptibility. It is suggested that an asphalt cement with a PVN less than -0.5 is temperature susceptible.

$$PVN = \frac{\text{Log A} - \text{Log V}}{\text{Log A} - \text{Log B}} \times (-1.5)$$

Where Log A = 4.25800 - 0.79674 Log (Penetration @ 77°F)
Log B = 3.46289 - 0.61094 Log (Penetration @ 77°F)
Log V = Log (Viscosity @ 275°F, Kinematic)

The results indicate that most of these asphalt cements are temperature susceptible by PVN criteria.

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	-0.450	-	-0.722	-0.476	-0.711
Range	-0.025 to -1.327	-	-0.495 to -1.107	-0.231 to -0.658	-0.678 to -0.733
Standard Deviation	0.528	-	0.268	0.167	0.029

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	4	6	3
Mean	-0.276	-	-0.677	-0.522	-0.724
Range	-0.039 to -0.503	-	-0.479 to -1.154	-0.247 to -0.776	-0.647 to -0.831
Standard Deviation	0.204	-	0.322	0.216	0.095

U. Penetration Index Numbers, (PIN)

The penetration Index Number is another indicator of temperature susceptibility of asphalt cements. Large negative values of PIN indicate greater temperature susceptibility. "Typical" asphalts have values between +2 and -2.

$$PIN = \frac{30}{1 + 90\ PTS} - 10$$

PTS = Penetration Temperature Susceptibility

$$PTS = \frac{\text{Log } 800 - \text{Log (Penetration @ } 77°F)}{\text{Softening Point } (°F) - 77°F}$$

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	0.378	-	-0.780	-0.350	-0.077
Range	+1.243 to -0.685	-	-0.370 to -1.197	-0.078 to -0.743	+0.249 to -0.246
Standard Deviation	0.755	-	0.265	0.272	0.283

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	3	-	3	2	2
Mean	1.448	-	0.936	-0.395	-0.629
Range	+4.616 to -0.611	-	+2.997 to -0.336	+0.015 to -0.804	-0.364 to -0.893
Standard Deviation	2.785	-	1.801	0.579	0.374

V. A Settling Test to Evaluate The Relative Degree of Dispersion of Asphaltenes

by

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The asphaltene settling test is used to evaluate the relative degree of dispersion of asphaltenes from paving asphalts. This test distinguishes differences in asphaltene settling times of asphalts in their hexane-maltene solutions. The test involves digesting asphalt in n-hexane, transferring the contents into a graduated cylinder and measuring the time required for the asphaltene meniscus to settle to the 25 ml. mark of a 50 ml. cylinder. Slower settling times indicate a greater degree of dispersion of the asphaltenes and thus a more compatible asphalt, which in turn is considered to be an important property that contributes to asphalt durability. The test is extremely sensitive to changes in asphalt composition. Time is reported in minutes.

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	35.9	-	41.7	50.7	50.8
Range	20.8 to 55.7	-	19.3 to 66.3	26.8 to 84.3	38.8 to 73.8
Standard Deviation	17.2	-	20.0	20.5	20.0

W. Separation of Asphalt Into Four Fractions Modified Method of ASTM D 4124-84 Section 4, Volume 04.03

The purpose is to separate the four generic fractions present in asphalt. These fractions are saturates, naphthene aromatics, polar aromatics, and asphaltenes. The relative amount of each fraction plays a role in determining the physical properties of the asphalt. These properties include viscosity, ductility, softening point and temperature susceptibility.

The procedure follows:

The percent asphaltene is determined by dispersing the asphalt in n-heptane and refluxing. The insolubles are the asphaltenes.

The remaining three fractions are determined by absorbing the deasphaltened n-heptane solution on a calcined alumina chromatography column and eluting (removing) each fraction with a different solvent. Saturates are eluted with n-heptane. Naphthene aromatics are eluted with toluene. Polar Aromatics are eluted with 50/50 toluene - methanol solution, followed by trichloroethylene. The solvents are then evaporated and weight percentages of each fraction with respect to the original asphalt sample are determined.

ASPHALTENES, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	13.1	-	12.1	15.2	16.2
Range	7.6 to 16.6	-	8.8 to 15.3	12.7 to 18.5	15.0 to 17.1
Standard Deviation	3.6	-	2.5	2.2	1.1

SATURATES, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	9.3	-	10.3	9.6	12.5
Range	6.5 to 11.6	-	8.2 to 14.0	7.5 to 13.4	11.7 to 13.5
Standard Deviation	2.1	-	2.0	1.9	0.9

NAPHTHENE - AROMATICS, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	30.1	-	29.9	29.0	31.8
Range	27.6 to 34.2	-	25.2 to 33.9	26.4 to 31.5	30.6 to 32.6
Standard Deviation	2.6	-	3.1	2.1	1.1

POLAR AROMATICS, %

1. Materials Bureau

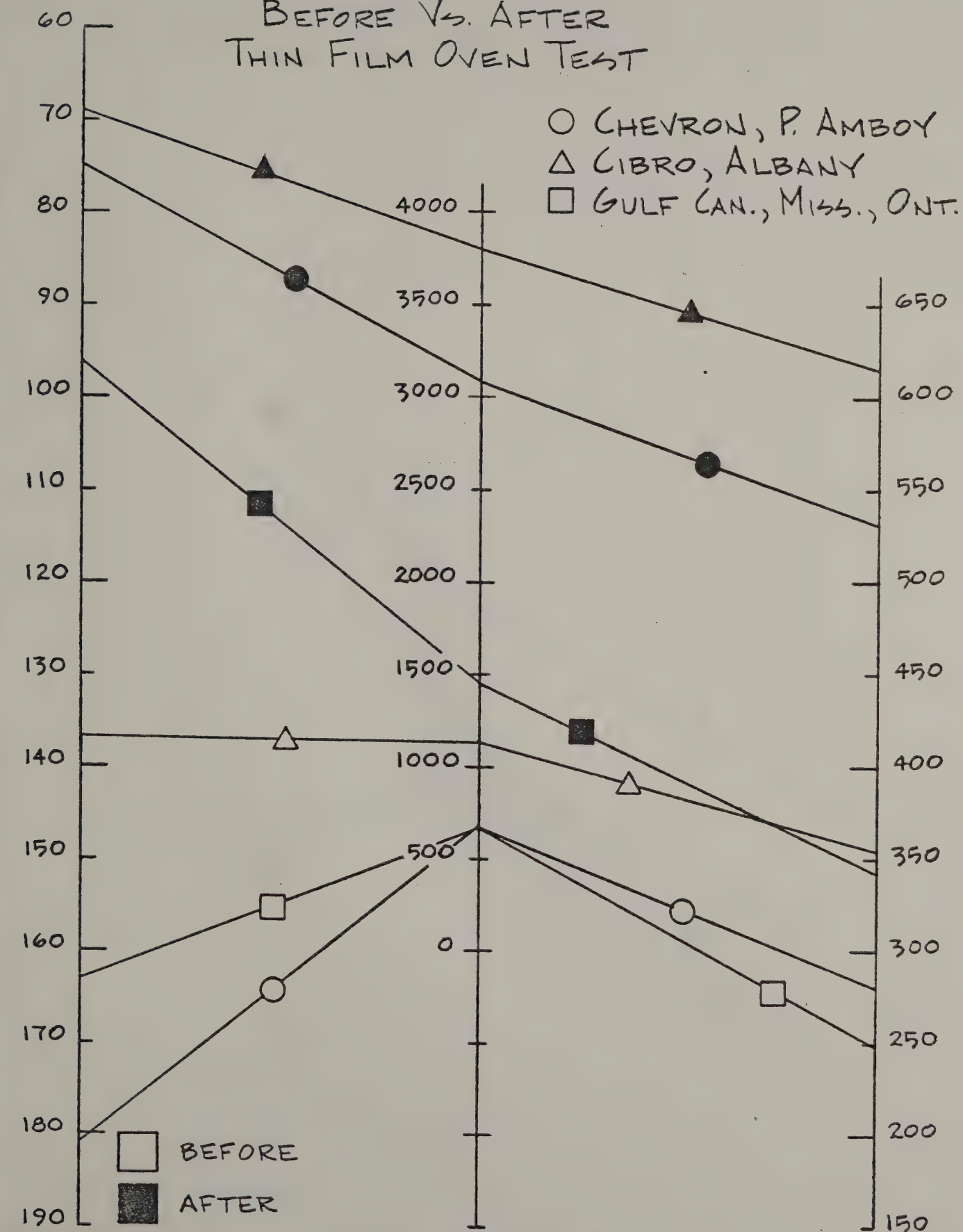
	FLUX	AC-5	AC-15	AC-20	85/100
Number of Samples	5	1	6	7	3
Mean	39.2	-	40.5	38.8	34.5
Range	37.5 to 41.0	-	39.0 to 43.6	37.4 to 41.7	33.6 to 35.5
Standard Deviation	1.5	-	1.6	1.6	1.0

IX. GRAPHS AND CHARTS OF RELATED MATERIAL INFORMATION

On the following pages are found a series of graphs and charts providing a comparison of thin film oven test, before and after, and charts showing asphaltene dispersion settling test.

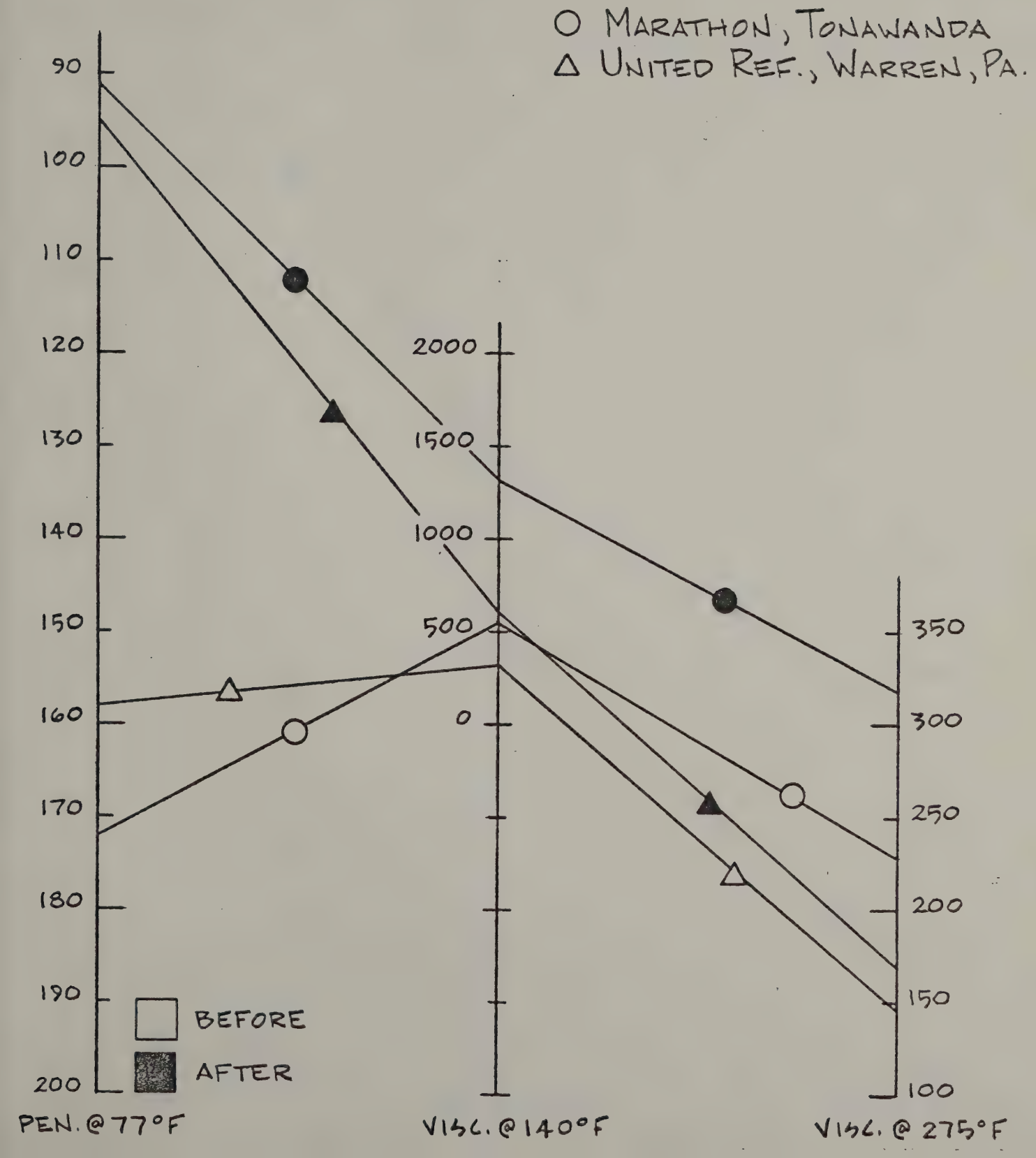
Comparison Flux, Before Vs. After Thin Film Oven Test

S.J.P.



Comparison Flux, Before Vs. After Thin Film Oven Test

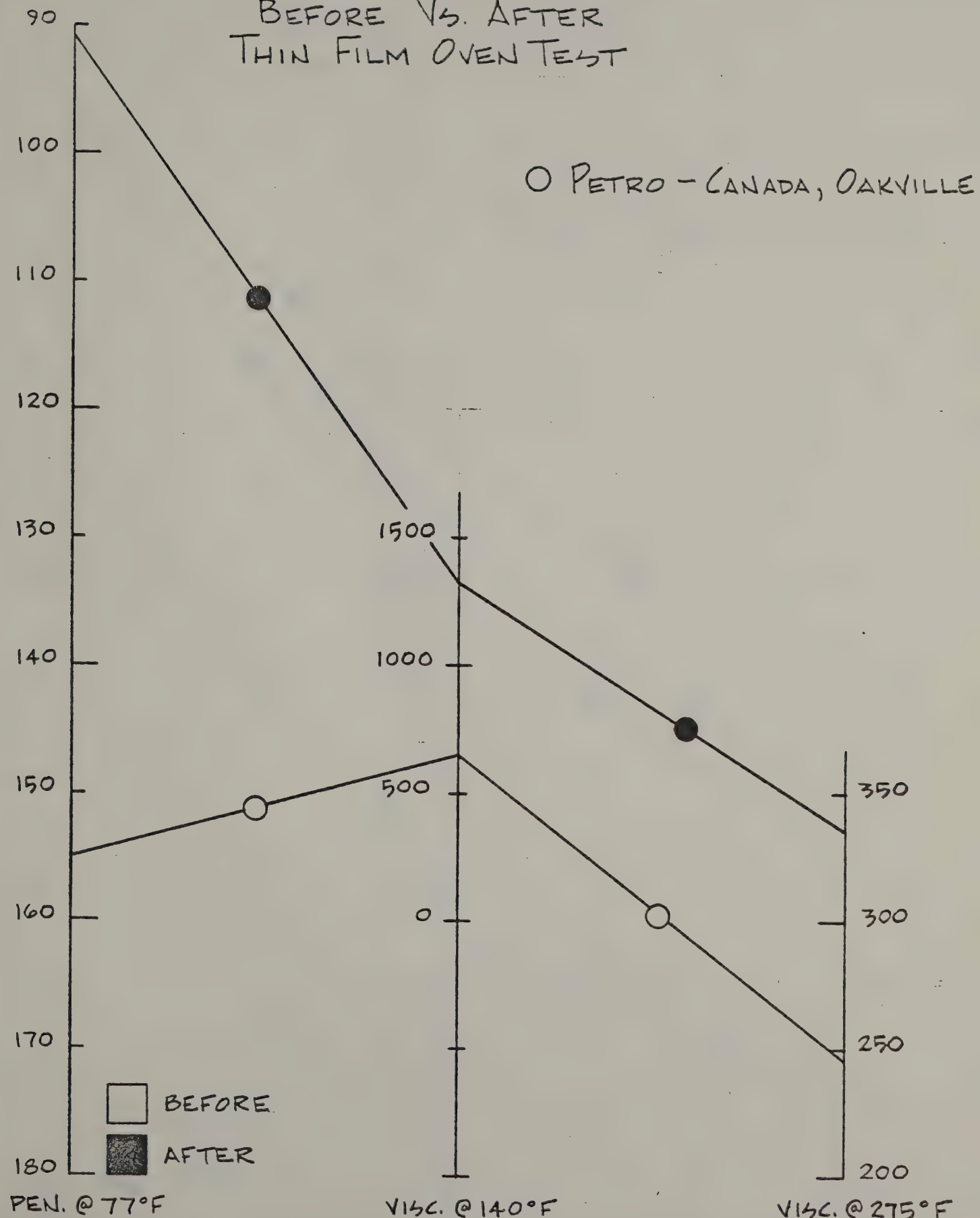
S.D.P.



Comparison AC-5, Before Vs. After Thin Film Oven Test

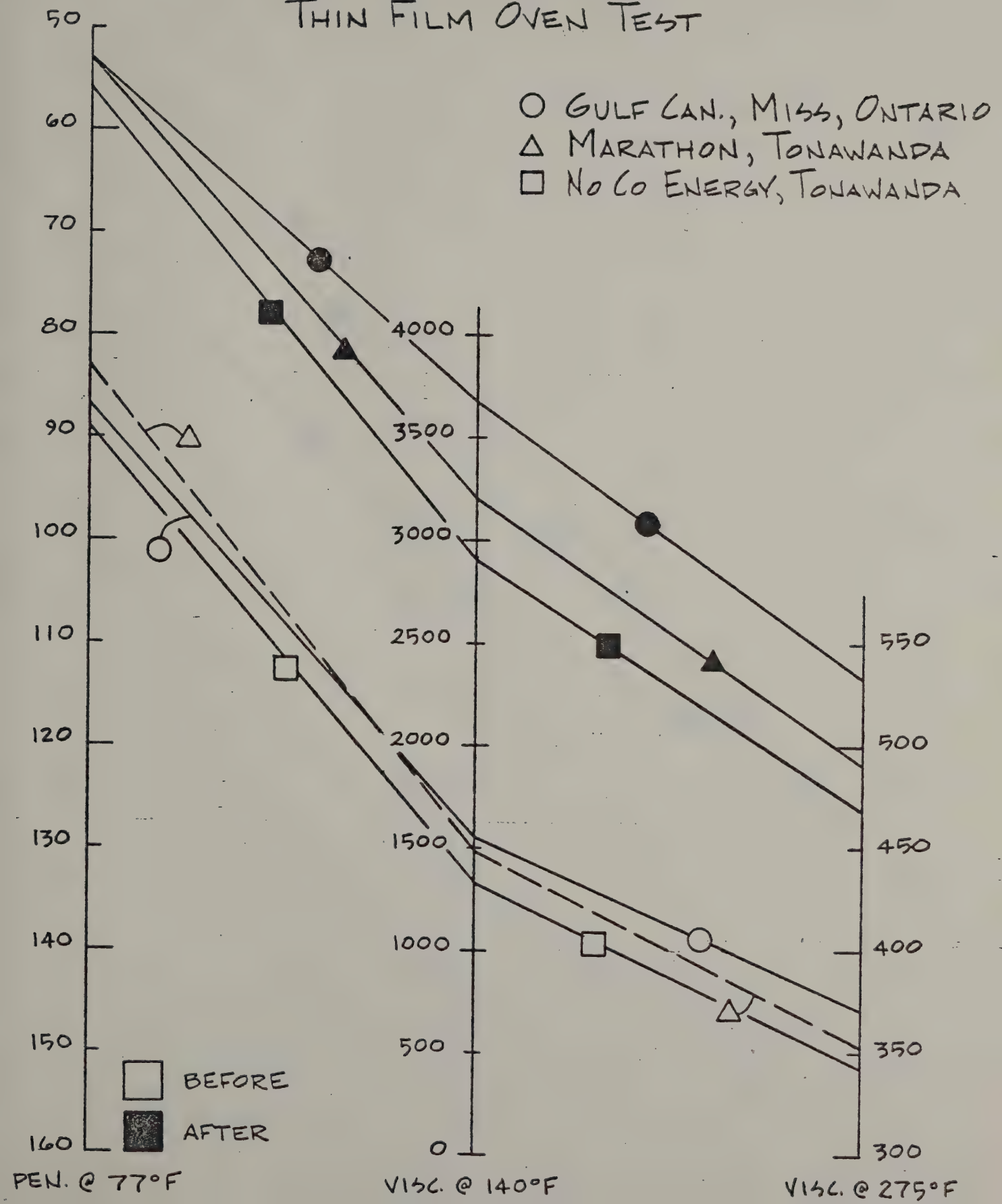
S.J.P.

○ Petro-Canada, Oakville



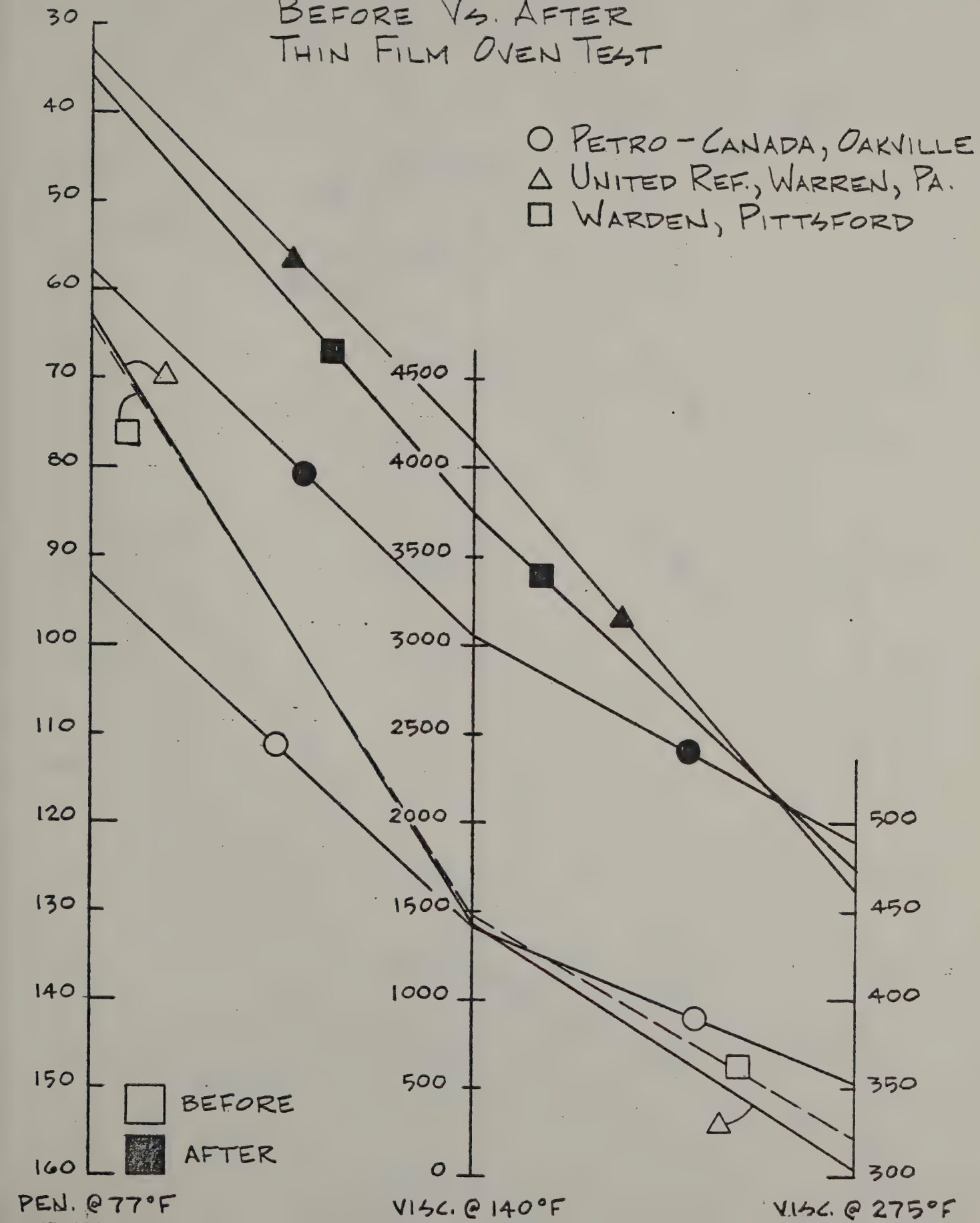
Comparison AC-15, Before Vs. After Thin Film Oven Test

S.J.P.



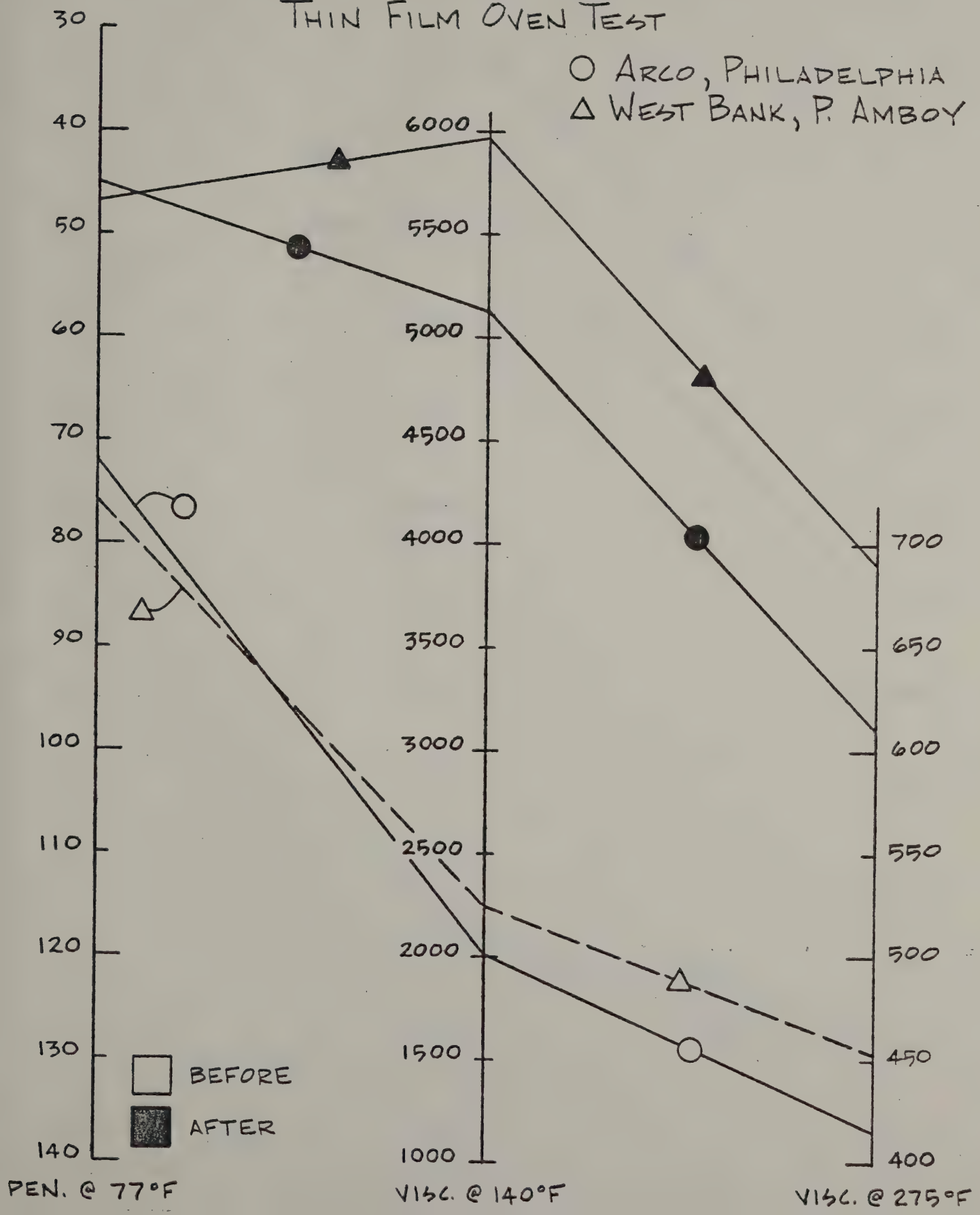
Comparison AC-15, Before Vs. After Thin Film Oven Test

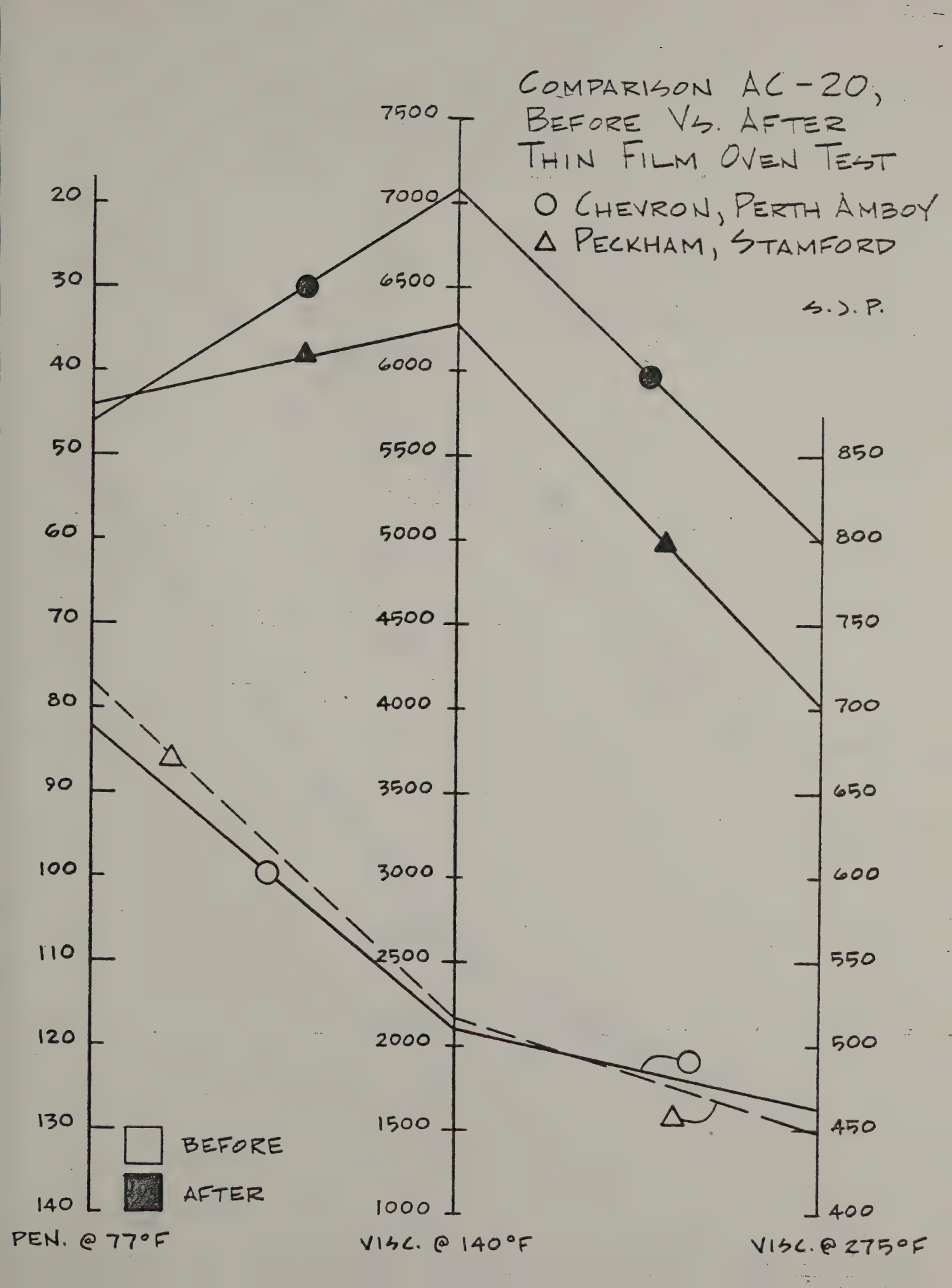
S.J.P.



Comparison AC-20, Before Vs. After Thin Film Oven Test

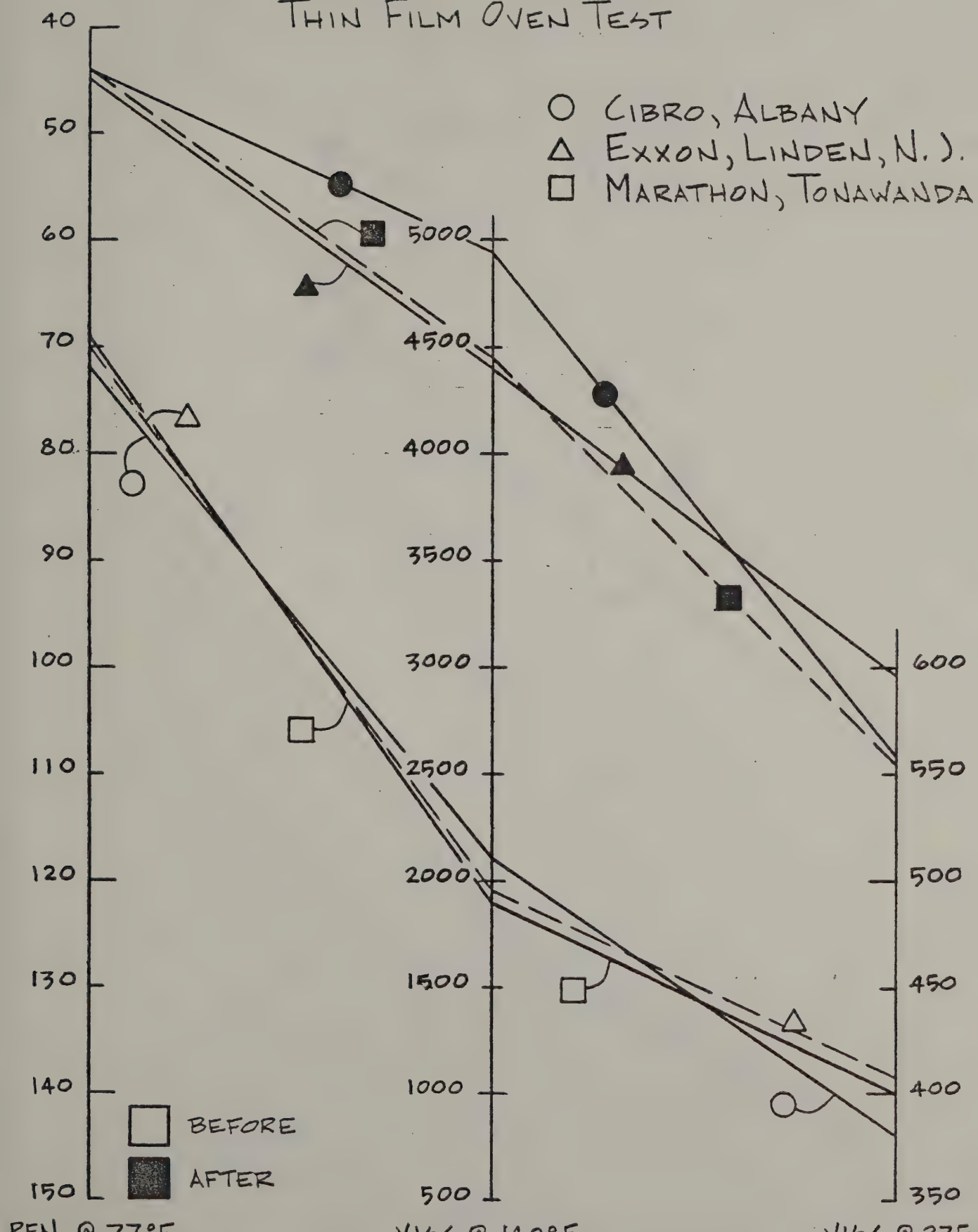
S.J.P.




COMPARISON AC-20,
BEFORE VS. AFTER
THIN FILM OVEN TEST
○ CHEVRON, PERTH AMBOY
△ PECKHAM, STAMFORD
S.S.P.
20
30
40
50
60
70
80
90
100
110
120
130
140
PEN. @ 77°F
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
VISC. @ 140°F
850
800
750
700
650
600
550
500
450
400
VISC. @ 275°F
BEFORE
AFTER

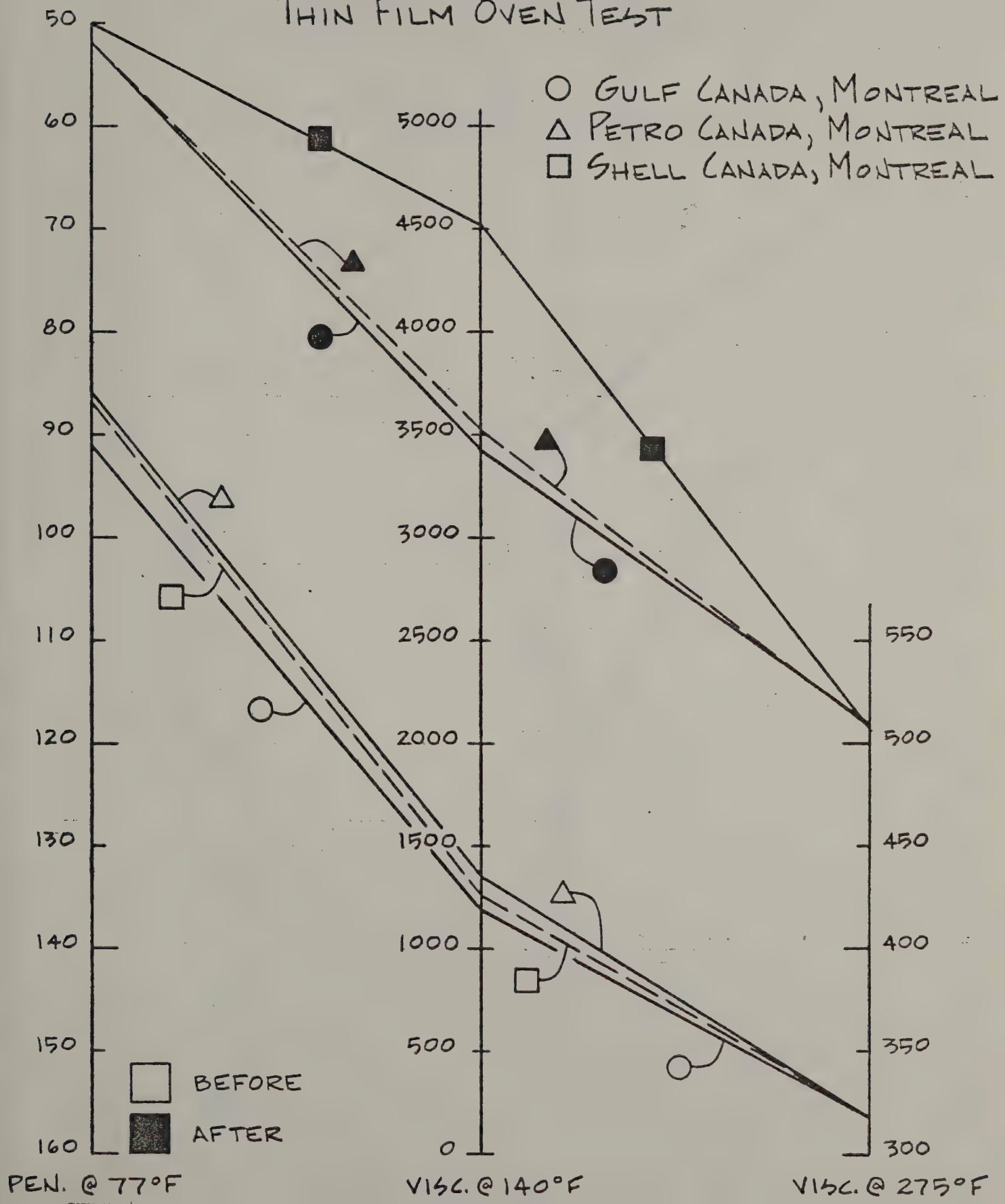
Comparison AC-20, Before Vs. After Thin Film Oven Test

S.J.P.

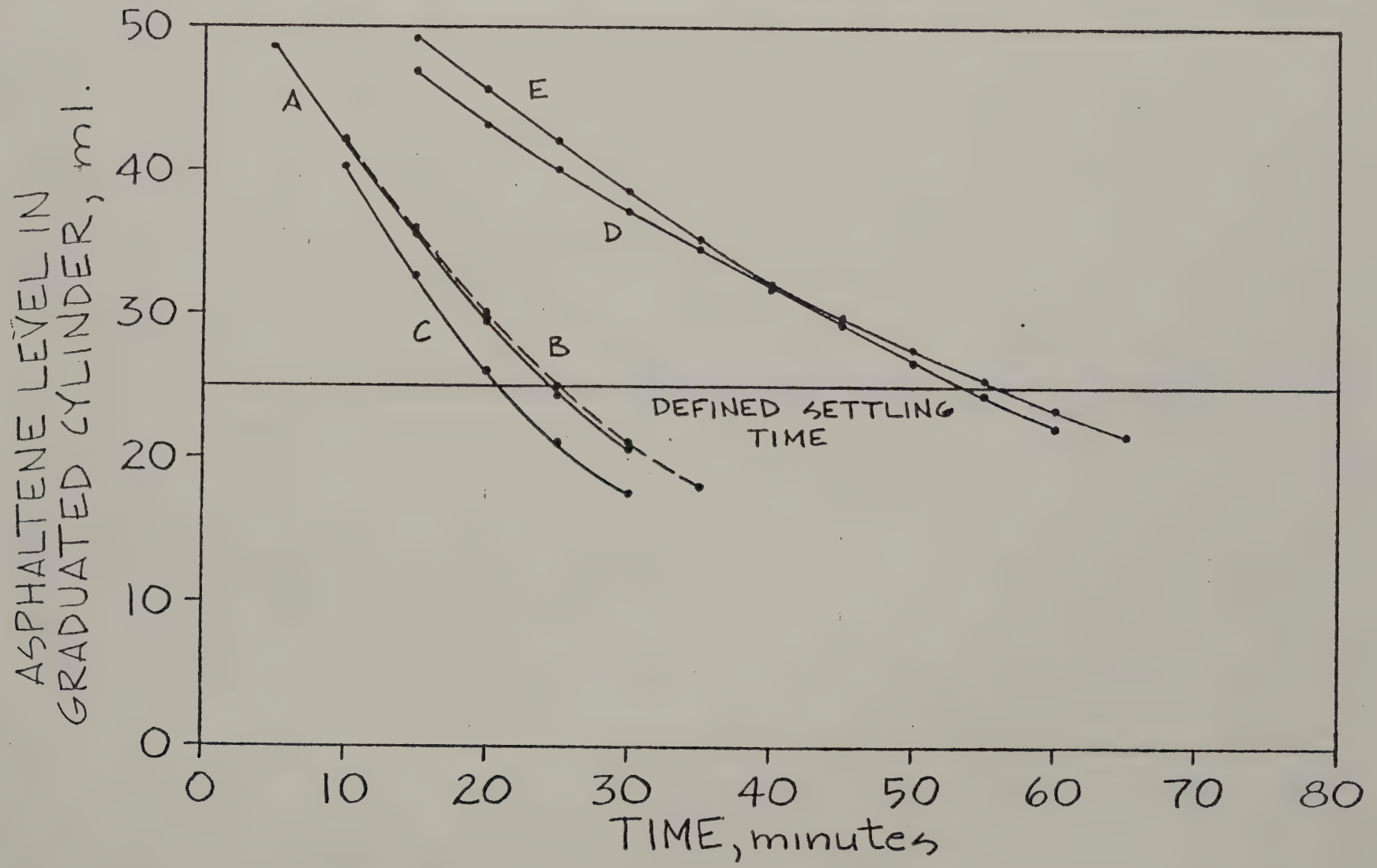


Comparison 85/100, Before Vs. After Thin Film Oven Test

S.J.P.



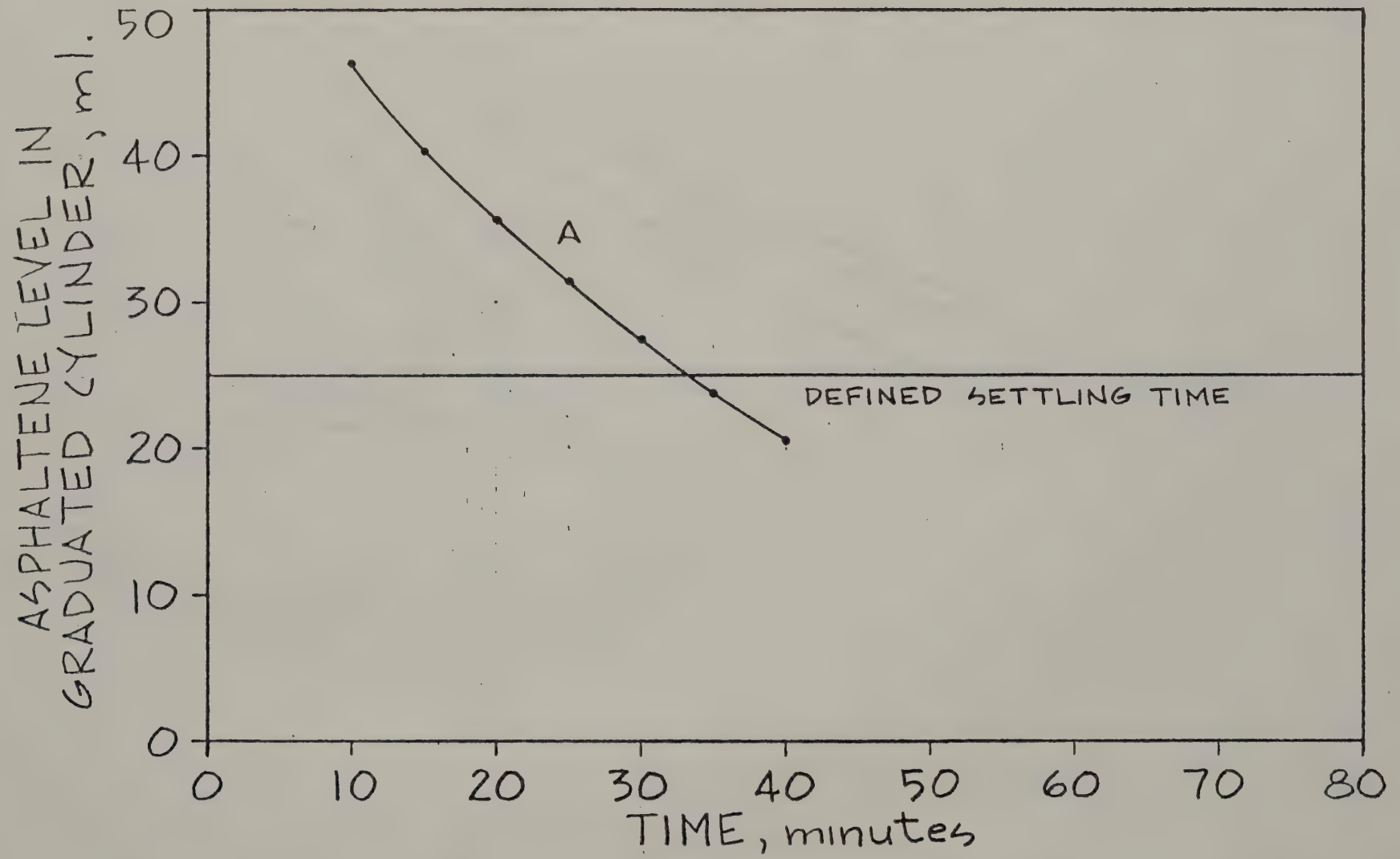
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = FLUX, CHEVRON, PERTH AMBOY
B = FLUX, CIBRO, ALBANY
C = FLUX, GULF CAN., MISS., ONTARIO
D = FLUX, MARATHON, TONAWANDA
E = FLUX, UNITED REF., WARREN

S.J.P.

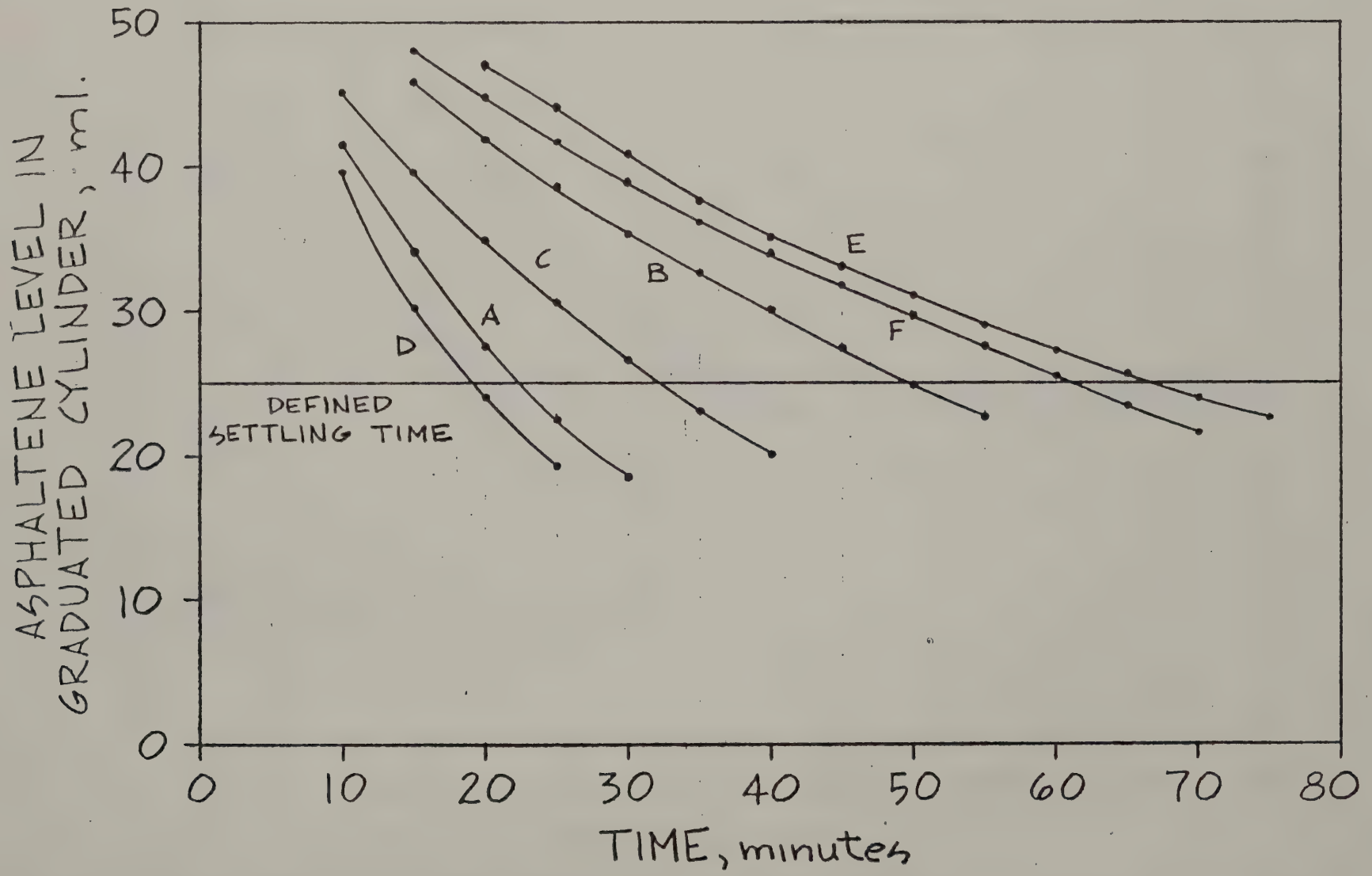
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = PETRO-CANADA, OAKVILLE, AC-5

S.J.P.

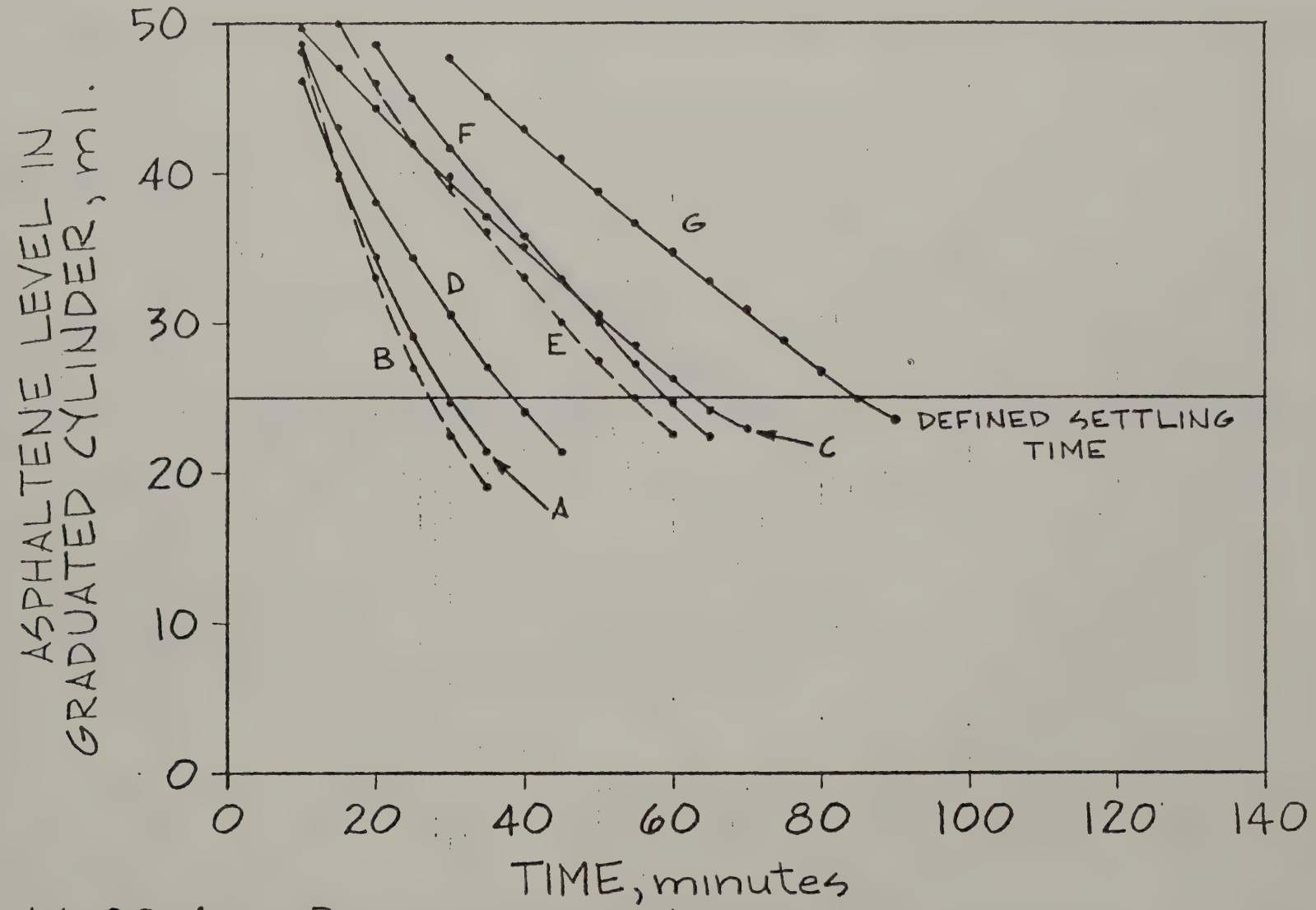
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-15, GULF CAN., MISS., ONTARIO
B = AC-15, MARATHON, TONAWANDA
C = AC-15, NO CO ENERGY, TONAWANDA
D = AC-15, PETRO-CAN., OAKVILLE
E = AC-15, UNITED REF., WARREN, PA.
F = AC-15, WARDEN, PITTSFORD

S.J.P.

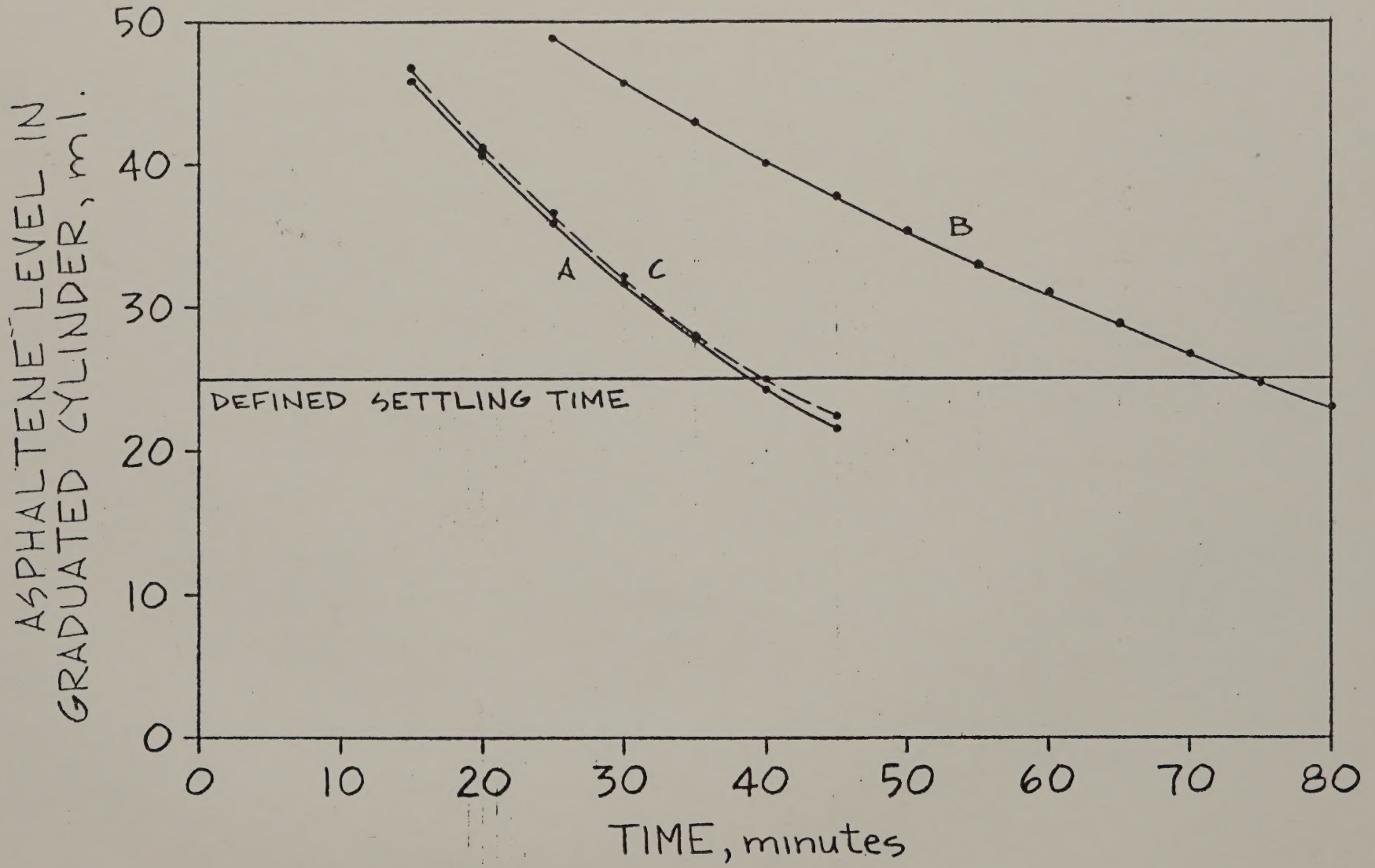
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-20, ARCO, PHILADELPHIA
B = AC-20, CHEVRON, PERTH AMBOY
C = AC-20, CIBRO, ALBANY
D = AC-20, EXXON, LINDEN, N.J.
E = AC-20, MARATHON, TONAWANDA
F = AC-20, PECKHAM, STAMFORD
G = AC-20, WEST BANK, PERTH AMBOY

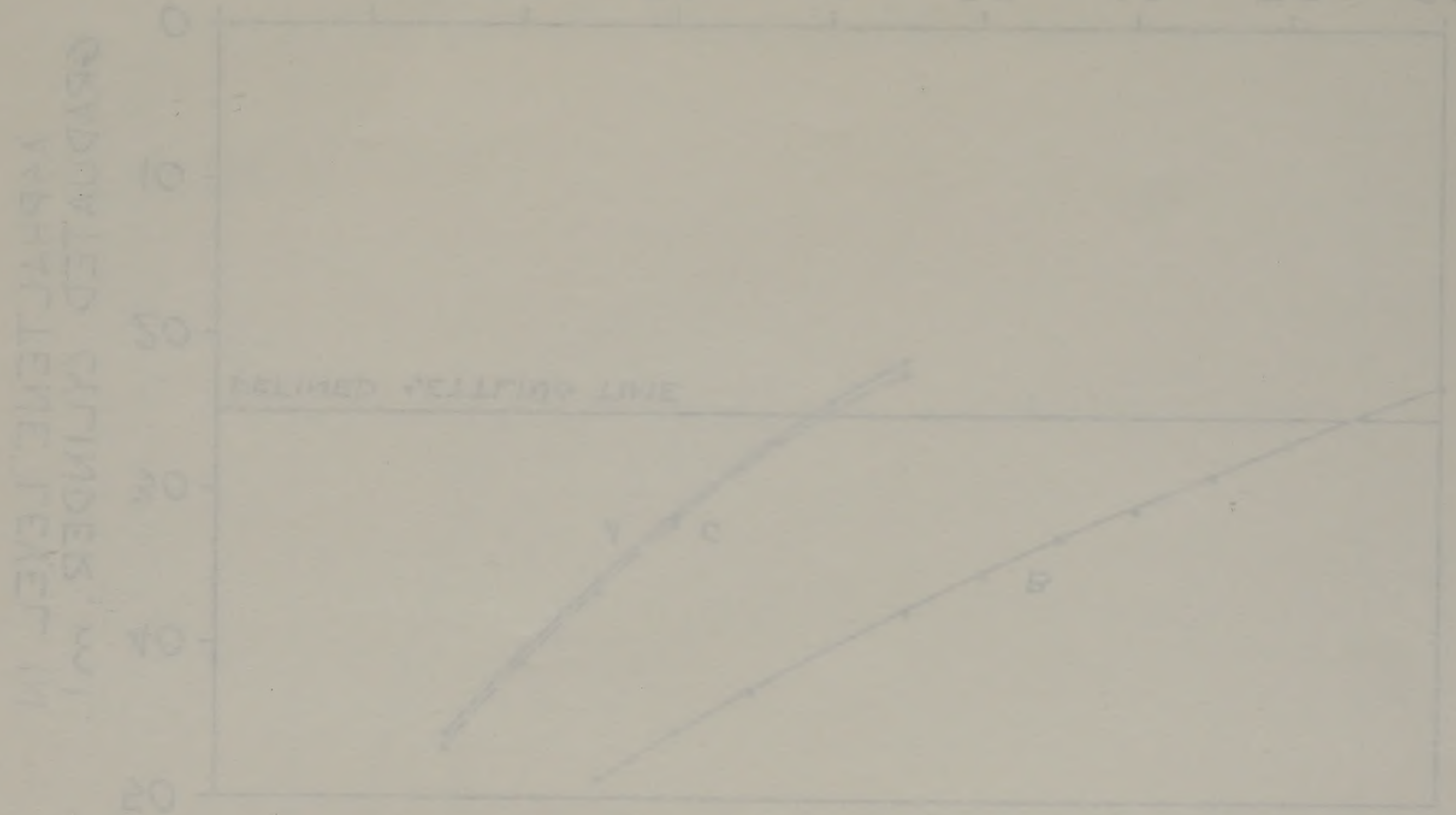
S.J.P.

A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = 85/100, GULF CANADA, MONTREAL
B = 85/100, PETRO CANADA, MONTREAL
C = 85/100, SHELL CANADA, MONTREAL

S.J.P.


DELAYED RELAXING TIME
A
B
C

01548
LRI